TEACHER EVENT CHECKLIST
SPACEBOTS EXPEDITION (ROBOTICS)

Date Completed	PRE EVENT REQUIREMENTS
	1. Print out a copy of this entire file (color copy preferred). Please note: this document is 18 pages long.
	2. Sign Agreement to Participate and fax to the Distance Learning Outpost at (281) 483-3789 within 3 business days of confirmation.
	3. Have students take Pre-Event Quiz on page 7.
	4. Complete all pre-event activities on pages 6 to 16 with the students.
	5. Teacher to fax or E-mail (preferred) a minimum of 5 student questions to our office no later than 3 business days prior to your event. (See page 6)
	6. Review NASA Event Guidelines on page 17 with students.
	DAY OF EVENT ACTIVITIES
	1. The students will be asked to share their results from their pre-work activities with the NASA DLO presenters.
	2. Bring classroom projects and drawings to support student presentations.
	POST EVENT REQUIREMENTS
	1. Have students take Post-Event Quiz on page 7 to demonstrate knowledge of subject.
	2. Teacher(s) and students to fill out event feedback. (See page 18)
	2. Distance Learning Outpost will respond to any follow-up questions.
	3. Students to complete extended activities on page 18 at Teacher's discretion.

Teacher(s) Agreement To Participate
NASA Johnson Space Center
Distance Learning Outpost

I have reviewed the SpaceBots Learning Module and agree to complete all of the required activities with my students, both prior to, and following, the video teleconferencing event.

Teacher(s) _____

School/Institution _____

Event # _____

Date of Event _____

SPACEBOTS

Instructional Goal:

Upon completion of this learning module, students will be able to discuss how robotics are used in space exploration and describe some of the career opportunities that exist in the field of robotics.

Learning Objectives:

1. Students will be able to define the term "robot" historically and identify everyday applications.

2. Students will be able to discuss the characteristics of robots and their role-use in space exploration.

3. Students will explore career opportunities and the education required in the field of robotics.

National Education Standards:

Science Standards (NSTA)

Science and Technology
- 5-8, Abilities of Technological Design

History and Nature of Science
- 5-8, Science as a Human Endeavor
- 5-8, Historical Perspectives

Technology Ed. Content Standards

8. Students will develop an understanding of the attributes of design

9. Students will develop an understanding of engineering design

Mathematics Standards

- Measurement K-12
- Connections K-12

Grade Level:

Grades 5-8

Time requirements:
1 class period to research definitions
2-3 class periods to perform pre-event activities
1 – Fifty (50) minute video teleconference

Students will present results and projects during the DLO event.

Texas Essential Knowledge and Skills (TEKS)

Science
- 3.E
- 5.A,B,C

Social Studies
- 29.A

English
- 15.A

OVERVIEW

Robots have been a staple of our culture for the past half-century. We have all seen them in movies, on television, and in science fiction stories performing tasks that range from the mundane to the extraordinary. Because of the mental images we have of robots, sparked in great measure by the influence of science fiction, we often fail to recognize how widespread their use is in our daily lives. Everywhere we look, robots and automated systems do work for us and help make our lives more convenient if not easier. Often we do not recognize real robots because they differ from the images we have of them and from the jobs we tend to believe they do. As our society becomes more technologically dependent, however, the role of robots will increase significantly and knowing what they do and how they do it will be an important factor in many professions of the future. NASA already uses robotics technology to a great extent in its exploration of space. During this Expedition, students and teachers will have an opportunity to learn firsthand about NASA's use of robots and how they are being designed and built to help humans explore the universe. Learn how NASA defines robotics; see how robotic systems are already widely used in the space program and what plans there are for future robotic applications. This interesting look into the world of space robotics will also highlight educational and professional opportunities that could be the catalyst that helps some students to identify a career path. So join us for this live, interactive learning session for a glimpse into the technologies of the 21st century happening now at NASA.

NATIONAL EDUCATION STANDARDS ADDRESSED

Science - National Science Teacher Association

Science and Technology
Abilities of technological design

5-8 **– Identify appropriate problems for technological design**. Develop their abilities by identifying a specified need and different potential users or beneficiaries.

5-8 – **Design a solution or product**. Students should make and compare different proposal in the light of the criteria they have selected. They must consider constraints and communicate ideas with drawings and simple models.

5-8 – **Implement a proposed design**. Students should organize materials and other resources, plan their work, make good use of group collaboration where appropriate, choose suitable tools and techniques, and work with appropriate measurement methods to ensure adequate accuracy.

5-8 – **Evaluate completed technological designs or products**. Students should use criteria relevant to the original purpose or need; consider a variety of factors that might affect intended users or beneficiaries. They should also suggest improvements and, for their own products, try proposed modifications.

History and Nature of Science
Science as a Human Endeavor

5-8 – Women and men of various social and ethnic backgrounds engage in the activities of science and engineering. Some scientists work in teams, and some work alone, but all communicate extensively with others.

Technology Education Content Standards

8. Students will develop an understanding of the attributes of design.
9. Students will develop an understanding of engineering design.

Mathematics

Measurement

K-12 Understand measurable attributes of objects and the units, systems, and processes of measurement. Apply appropriate techniques. Tools, and formulas to determine measurements.

Connections

K-12 Recognize and use connections among mathematical ideas. Understand how mathematical ideas interconnect and build on one another to produce a coherent whole. Recognize and apply mathematics in contexts outside of mathematics.

TEXAS ESSENTIAL KNOWLEDGE AND SKILLS

Science

(3) Scientific Processes. The student uses critical thinking and scientific problem solving to make informed decisions. The student is expected to:

(E) Connect Grade 8 science concepts with the history of science and contributions of scientists.

(5) Scientific Processes. The student knows that relationships exist between science and technology. The student is expected to:

(A) Identify a design problem and propose a solution
(B) Design and test a model to solve the problem; and
(C) Evaluate the model and make recommendations for improving the model.

Social Studies

(29) Science, technology, and society. The student understands the impact of scientific discoveries and technological innovations on daily life in the United States.

(A) Compare the effects of scientific discoveries and technological innovations that have influenced daily life in different periods in U.S. history

English/Language Arts (Post Activity)

(15) Writing/purposes. The student writes for a variety of audiences and purposes and in a variety of forms. The student is expected to:

(A) Write to express, discover, record, develop, reflect on ideas, and to problem solve (4-8).

INSTRUCTIONAL STRATEGY

Pre-VTC Classroom Component

Class #1

1. Students take Pre-Event Quiz on page 7 to test their knowledge prior to these lessons about Robotics-. Students keep these quizzes on file to compare to their Post-Event Quiz.

2. Develop a class definition of a Robot and introduce additional terminology on page 11 when appropriate with students.

3. Have students read "Educational Brief, Humans and Robots" located at:

   http://spacelink.nasa.gov/Instructional.Materials/NASA.Educational.Products/Humans.and.Robots/Humans.and.Robots.pdf

Class period #2-3 (additional classes may be added as required)

1. Select one activity that is appropriate for your classroom from each activity set. There are 2 levels provided for each activity: 1) grades 5-6 and 2) grades 5-12. Please select the most appropriate one. Distribute your selected Activity Set #1 on page 12 or Activity Set #2 on page 14. Have students work individually or in teams to complete their activity. **Students will be asked to present their ideas, results, and designs during the video teleconference.**

2. As a class, develop at least 5 questions associated with robotics that you would like to ask during the video teleconference and E-mail them to DLO1@jsc.NASA.gov or fax them (281) 483-3789 at least 3 business days prior to your scheduled connection time.

3. Conclude class by informing students that they are now ready to participate in a live, interactive video teleconference with the NASA Johnson Space Center where astronauts train to use robotic systems onboard the Shuttle and ISS and where engineers are developing a variety of robots for future space missions.

Robotics
Pre/Post Quiz

1) Provide a written definition of a Robot. What can a robot do? What does a Robot look like?

2) Provide an illustration that shows a typical Robot used for Space Exploration?

3) Write a set of directions on how to move your arm from your side to scratch your nose. This will be a set of program directions similar to those written by engineers working to design a robotic system for movement to complete a task.

4) List at least 3 jobs or careers in robotics.

5) Match the following terms with their correct definitions:

Articulated	A mechanical or electromechanical device that performs human tasks, automatically or by remote control.
End Effector	The study and application of robot technology.
Degrees of Freedom	Each plane in which a robot can maneuver.
Anthropomorphic	To move by turning over and over. To rock back and forth.
Dexterity	Jointed arm.
Yaw	To move left or right with out turning over or moving up or down
Pitch	To control a device or object from a distant location.
Roll	To have human characteristics.
Autonomous	A robot that is operated remotely.
Robot	Device at the end of a robot arm that is used to grasp or engage objects.
Telerobotics	To rise up or dip down.
Teleoperation	Skill, flexibility, and range of mobility.
Robotics	Existing or functioning independently

Robotics
Pre/Post Quiz
TEACHER ANSWER KEY – Please don't share with the students. Answers should be similar to:

1. Provide a written definition of a Robot. What can a robot do? What does a Robot look like?

   Generally, robots are machines that operate by computer controls. A mechanical or electromechanical devise that performs human tasks, either automatically or by remote control. It senses, thinks, and then acts.

2. Provide an illustration that shows a typical Robot used for Space Exploration?

   Any creative ideas are acceptable.

3. Write a set of directions on how to move your arm from your side to scratch your nose. This will be a set of program directions similar to those written by engineers working to design a robotic system for movement to complete a task.

   Any thoughtful responses are acceptable.

4. List at least 3 jobs or careers in robotics.

   Design Martian rovers
   Build spaceman robot
   Robotics careers can include the fields of:
   - Mechanical Engineering
   - Electrical Engineering
   - Computer Engineering
   - Materials Science
   - Biomedical Engineering

5. Match the following terms with their correct definitions:

Articulated – Jointed arm

End Effector – Device at the end of a robot arm that is used to grasp or engage objects

Degrees of Freedom – Each plane in which a robot can maneuver

Robot – Mechanical or electromechanical device that performs human tasks, either automatically or by remote control (From the Czech work robota)

Robotics – Study and application of robot technology

Telerobotics – Robot that is operated remotely

Teleoperation – To control a device or object from a distant location

Anthropomorphic –To have human characteristics

Dexterity – Skill in using one's hands, body, or mind. Skill, flexibility, and range of mobility.

Yaw – To move left or right with out turning over or moving up or down

Pitch – To rise up or dip down

Roll – To move by turning over and over. To rock back and forth.

Autonomous – existing or functioning independently

Robotics Terminology

Articulated – Jointed arm

End Effector – Device at the end of a robot arm that is used to grasp or engage objects

Degrees of Freedom – Each plane in which a robot can maneuver

Robot – Mechanical or electromechanical device that performs human tasks, either automatically or by remote control (From the Czech work robota)

Robotics – Study and application of robot technology

Telerobotics – Robot that is operated remotely

Teleoperation – To control a device or object from a distant location

Anthropomorphic –To have human characteristics

Dexterity – Skill in using one's hands, body, or mind. Skill, flexibility, and range of mobility.

Yaw – To move left or right with out turning over or moving up or down

Pitch – To rise up or dip down

Roll – To move by turning over and over. To rock back and forth.

Autonomous – existing or functioning independently

Classroom Activity #1
(Choice A for grades 5-6)

Robot Arm and End Effector

Materials

- Wooden craft sticks
- Drill
- Small brass paper fastener
- Assorted materials

Background

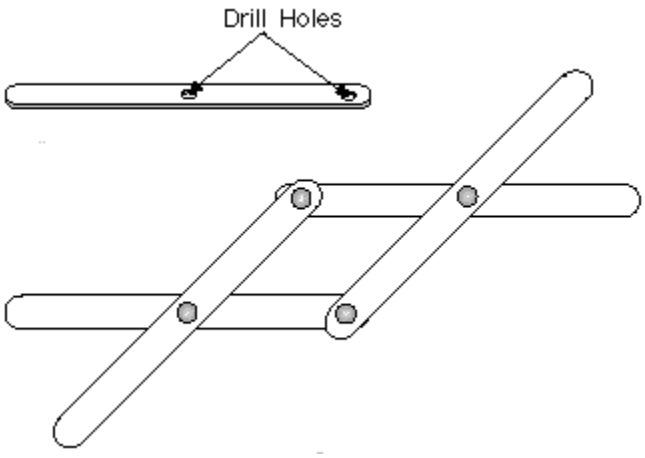
One of the important objectives in the development of robots is to enable robots to interact with their environment. Interaction is often accomplished with some sort of arm and gripping device or end effector.

Procedure

Drill holes through the craft sticks as shown in the diagram. Each student will need four drilled sticks and four brass paper fasteners. Dampening the sticks before drilling can reduce cracking the wood. Have students assemble robot arms as shown in the illustration above. Tell them to try to pick up a pencil or some other object with the arm. They will find the task difficult. Next, tell the students to design some sort of end effector for the end of the arm that will enable them to pick up the object. Students should make their end effector and attach it to the ends of the arm with glue. Evaluate their work by having them demonstrate picking up the object. Ask students what other objects they can pick up with the arm. Would the arm and end effector have to be modified to pick up sediment and pebbles on Mars?

Presentation

Students will be asked to demonstrate their robot arm and end effector during the video teleconference.



Classroom Activity #1
(Choice B for grades 5-12)

Shuttle-ISS Robot Arm End Effector

The activity is located on page 3 and 4 of this document:

http://spacelink.nasa.gov/Instructional.Materials/NASA.Educational.Products/Humans.and.Robots/Humans.and.Robots.pdf

Presentation
Students will be asked to demonstrate their robot arm and end effector during the video teleconference.

Classroom Activity #2
(Choice A for grades 5-6)

Can a Robot Tie Your Shoes?

Background

Robots are machines that do specific tasks. Movies are full of robots that can do everything that humans can do and more. However, in reality, there are limits to what robots can do. This activity is designed to help analyze a simple, everyday task from the point of view of a robot. Gloves, blindfolds and pliers are used to limit sensory information, and tongue depressors limit the number of moving joints.

Tying a shoe, an every-day task that seems easy enough for us, is difficult, if not impossible, for a mechanical robot. Robots have limited movement, only a few sensors, and are controlled by computers, which must be programmed with instructions for each step required. It is difficult for two people to work together to tie a shoe. Likewise two robots working together is very difficult to coordinate and only recently has been achieved. (A line of robots working sequentially in an assembly plant is different than two robots working together on the same task.)

It is helpful for participants to discuss their experience after each variation.

Materials Needed

- shoes that tie
- tongue depressor
- masking tape
- heavy gloves
- 2 pairs of pliers
- blind folds

Procedure

Try tying your shoes blindfolded. Not too hard! Now, repeat the activity but with heavy gloves on your hands. Then, tape tongue depressors onto your thumbs and forefingers and try again.

And if those activities weren't difficult enough, tie your shoes with pliers. First, use pliers in both hands; then with only one hand; finally with two people -- each with one pair of pliers. For fun, these activities can be set up as a race between two people

Presentation

Students will be asked to share their experiences & findings during the video teleconference.

Classroom Activity #2
(Choice B for grades 5-6)

Design a Microrover for the Moon

Materials

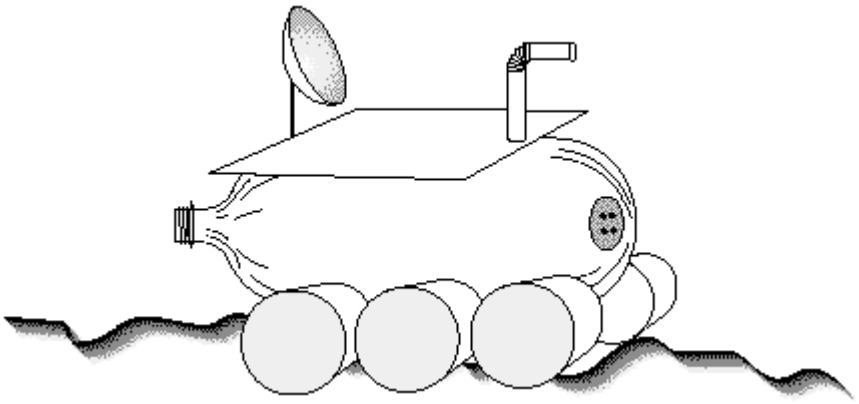
- paper
- art supplies
- assorted materials (plastic food containers, Styrofoam packaging, spools, broken toys, etc.)
- glue
- tape

Background

NASA has shifted its planetary exploration strategies from complex and expensive "do-everything" spacecraft to simpler and less expensive spacecraft that do only a few jobs. A good example of this operational change is the Sojourner microrover robot spacecraft that explored small areas of the Martian surface in 1997. Microrovers are easier to design and construct than the larger complex craft and several can be constructed for the same price. If a major malfunction should take place in one rover, others can be deployed to replace it. Recent studies of the Moon by the robot Lunar Prospector spacecraft have confirmed that water, in the form of ice, exists at the Moon's South Pole. The water is found in depressions that are forever shielded from the Sun's heat. The discovery of water means that future human explorers of the Moon can use the water for drinking, for production of breathing oxygen, and for production of rocket fuel.

Procedure

Challenge students to design a microrover spacecraft for exploring the Moon's South Pole region. The purpose of the rover is to map the extent of water ice found there. The robot will have to have some sort of transportation system, sensors, power, scientific instruments, and a communication system. Have students sketch their robot design or construct a model of the robot from assorted materials. Have students write a description of how their robot works or present an oral report.



Presentation

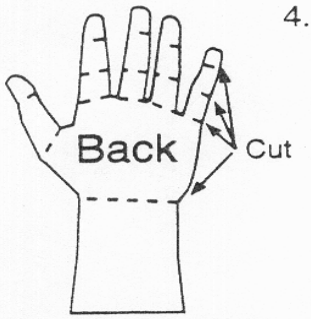
Students will be asked to demonstrate their microrover during the video teleconference.

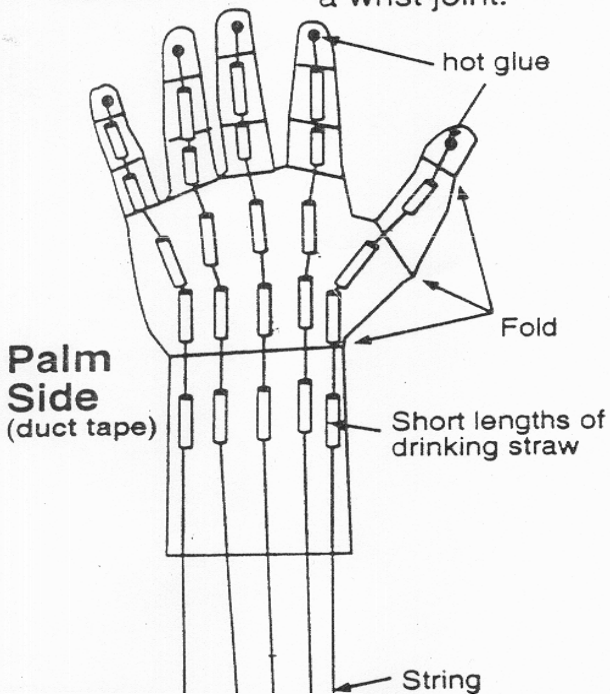
Classroom Activity #2
(Choice C for grades 5-12)

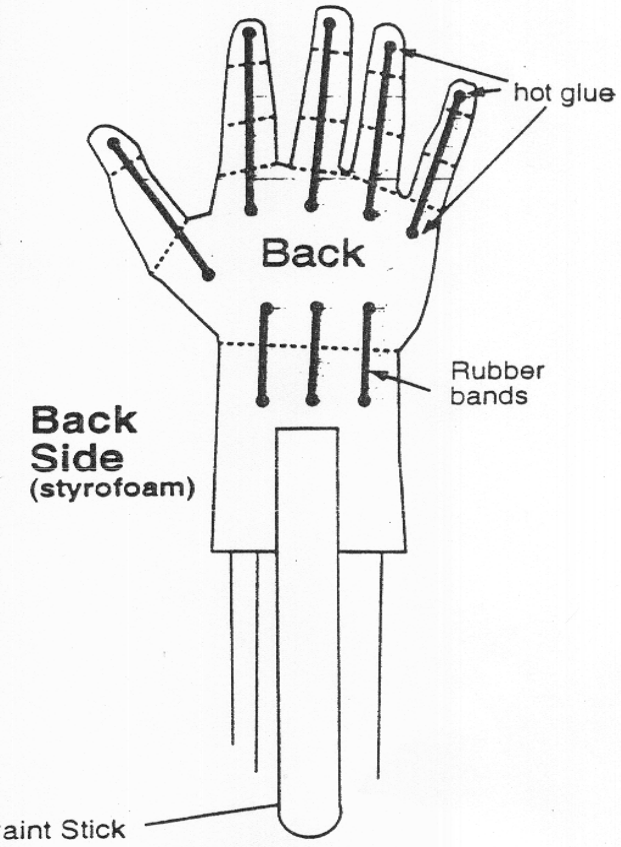
Robot Hand
(End Effector)

Instructions

1. Place your hand with fingers spread on the smooth side of a styrofoam food tray. Use a marker pen to trace your hand.
2. Cover the tracing of your hand with duct tape and press it smooth.
3. Trace your hand again on the duct tape and cut it out with a scissors.
4. Turn the hand over and score the styrofoam on each finger with the point of a ballpoint pen where the knuckles should be. Bend each joint gently the styrofoam "pops." The tape on the other side becomes the hinge of the knuckle. Also make a wrist joint.
5. Glue short lengths of straw on palm side of hand where indicated on diagram.
6. Knot 5 pieces of string on one end and glue knots to fingertips. Run the other end of the strings through the straws as shown.
7. Glue a paint stick to the forearm.
5. Glue pieces of rubber bands across each knuckle joint on the styrofoam side to serve as muscles and tendons. The rubber bands must be stretched enough so that all the fingers on the hand will open automatically.
8. Work the hand by pulling on the strings.







Vogt/Shearer 1999

Presentation

Students will be asked to demonstrate their robot hand during the video teleconference.

NASA Event Guidelines

Review the following points with your students prior to the video teleconference event:

1. A video teleconference is a two-way event. Students and NASA presenters can see and hear one another.
2. Students are representing their school; they should be on their best behavior.
3. Students should be prepared to give brief presentations, ask questions and respond to the NASA presenters.
4. A Teacher(s) or other site facilitator should moderate students' questions and answers.
5. Students should speak into the microphone in a loud, clear voice.

Get Ready, Be Ready, and have fun with your Distance Learning Event with NASA!

Post-VTC Classroom Component

Post Event Follow Up And Assessment

1. Students and Teachers are welcome to e-mail the Distance Learning Outpost with any follow-up questions from the event at: mailto:DLO1@jsc.nasa.gov
2. We want to know where we excel and where we have room for improvement. Your candid and thoughtful reply will help with our evaluation. Most are able to complete the questionnaire in less than 10 minutes. Your response and any comments will be treated with utmost confidentiality. We welcome any input that you have at the following sites:

    - Teacher Feedback Form:

      https://ehb2.gsfc.nasa.gov/edcats/centers/distance_learning.html
    - Student 4-12 Feedback Form:

      https://ehb2.gsfc.nasa.gov/edcats/centers/dlo_412_student.html
    - Technical Contact Feedback Form:

      https://ehb2.gsfc.nasa.gov/edcats/centers/jsc_dlo_tech_contact.html
    - Parent/Chaperone Feedback Form:

      https://ehb2.gsfc.nasa.gov/edcats/centers/distance_learning_parent.html
3. Please send us any photos, video, web page link, newspapers articles, etc. of your event. We will be glad to post them on our web page!

Extended Activities and Additional Resources

1. Robotics Education Project
   The NASA Robotics Education Project (RE) is dedicated to encouraging people to become involved in science and engineering, particularly building robots. Learn about robotics competitions and how to get involved. http://robotics.nasa.gov/
2. NASA Space Telerobotics Program
   This program is an element of NASA's ongoing research program, under the responsibility of the Office of Space Science. The program is designed to develop telerobotic capabilities for remote mobility and manipulation, by merging robotics and teleoperations and creating new telerobotics technologies.
   http://ranier.hq.nasa.gov/telerobotics_page/telerobotics.shtm
3. About Robots
   Facts, Use, Real World Applications, Short History, Laws of Robotics.
   http://www.occdsb.on.ca/~proj4632/learnmore.htm
4. A great NASA site for robotic rover technology research being conducted at the Jet Propulsion Lab in California at http://www.jpl.nasa.gov/videos/technology/mars_rovers.html
5. FIRST robotic competition link http://robotics.arc.nasa.gov/archive/webcasts.htm
6. First Lego League Robotic Competition. Involve your students in Lego's Mindstorm based creative robotic competition and research. http://www.usfirst.org/jrobtcs/flego.htm
7. Cool Robot of the Week site http://ranier.hq.nasa.gov/Telerobotics_page/coolrobots.html
8. Rover Ranch http://prime.jsc.nasa.gov/ROV/
9. Careers in Robotics
   "Women Working on Mars" web cast dated May 16th. It will take a lot of people to make the Mars Exploration Rover mission a success-and many of them are women. Through the "Women Working on Mars" web cast you'll meet with some of the women scientists, engineers, artists, web designers, and others who help make Mars exploration possible.
10. Perform further research on the Internet about robotics at NASA:
    http://spacelink.nasa.gov/Instructional.Materials/Curriculum.Support/Technology/Robotics/